A DIPHTHERIA EPIDEMIC related to Community Immunization Levels and the Health Problems of Migrant Workers

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DIPHTHERIA CASES and deaths in the United States fell steadily over the past three decades until 1958, when there was an abrupt halt in this trend (*1, 2*). It is not clear why the long-term decline in this country has not continued.

An important factor in the leveling off of reported cases is thought to be the occurrence of diphtheria cases within segments of the American population that remain unimmunized. Thus, most reported outbreaks of recent years have been concentrated within the Negro population of the southern and south central United States (*1*), a population dependent mainly on community health facilities rather than private physicians for immunizations. There is evidence that, as with poliomyelitis immunization (*3, 4*), diphtheria immunization levels are generally lower among such lower socioeconomic groups (*5*).

During the winter of 1960 a sharp outbreak of diphtheria occurred in Plainview, Tex. With the aid of the Plainview Department of Health and the Texas State Health Department, cases and epidemiologic factors in the outbreak were investigated by the Diphtheria Surveillance Unit of the Communicable Disease Center, Public Health Service.

The studies carried out following the epidemic disclosed that most of the cases were among children of population groups with low immunization levels. Through a strenuous community effort these low immunization levels were essentially reversed. Indirect evidence implicated migrant American agricultural workers of Mexican descent as of additional importance in the origin of the epidemic.

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The Community

Plainview is a city of 18,700 in the Texas Panhandle, the center of rich, irrigated Hale County, where cotton, grain, castor beans, and cattle support a predominantly agricultural

economy. Of the population, approximately 13,500 (72 percent) are Anglo-American, 4,100 (22 percent) are Latin American, and 1,100 (6 percent) are Negro. The total indigent population is variably estimated to number 3,000 to 5,000.

About half of the Latin Americans of Plainview are semipermanent residents, and many have steady jobs in the large cotton compresses. Others follow the crops as part of the estimated 170,000 migrant agricultural workers in Texas (*6*), using their Plainview quarters as a base for travel within the State or to other areas (fig. 1). These families travel as far east as South Carolina, as far north as Minnesota, and as far west as California, returning to Plainview for the autumn cotton harvest.

Most Latin American families of the city, during harvest season, have one or more members doing agricultural work. During fall, and to a lesser extent earlier in the summer, an estimated 4,000 to 7,000 additional Latin American migrant workers enter the Plainview area to harvest or cultivate cotton. Living conditions for many of the families, both stable and migrant, are exceedingly poor.

The city-county health unit at the time of the outbreak was small and included the city health director and a full-time nurse. A weekly clinic was held in the largest Latin American settlement, and a volunteer health nursery located in the Negro area offered well-child care to these families. A city-county hospital provided private and charity medical care. About 25 physicians practiced within the city, including 2 pediatricians, 3 internists, and 2 surgeons.

Hale County's last recorded diphtheria outbreak was in 1950, when 12 cases were reported. Prior to the 1960 outbreak no case had been reported since 1954 and 1955, when there were single cases.

Materials and Methods

Suspected cases were reported by private physicians or school nurses to the health unit. These persons and their contacts were then investigated, and nasal or oropharyngeal specimens were collected and cultured. Primary isolations were performed mainly at a single private medical laboratory, which then forwarded specimens to the Texas State Health Department Laboratory for toxigenicity testing. Selected isolates were typed by the Communicable Disease Center.

Exposure and occupational histories and immunization data were obtained for each case through interview of patients' families and review of physicians' records. School absences were reviewed for epidemiologic clues.

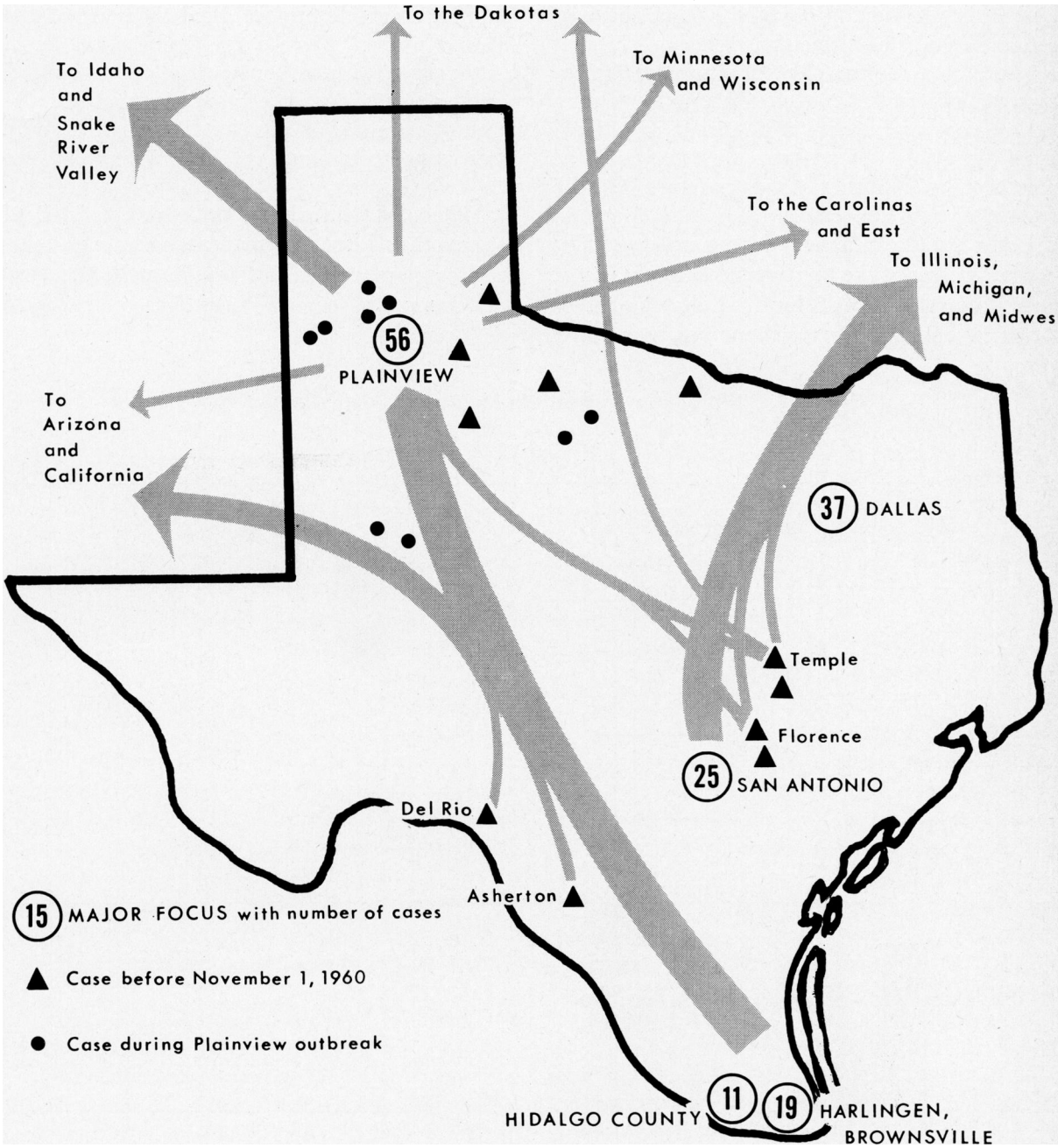
Background information on population movements within the Plainview area was supplied by the Texas State Employment Service, the Public Health Service, the U.S. Department of Labor, and Dr. E. W. Jones (*6*). Additional basic data on the work and travel habits of Latin American families were obtained by interviewing these families during an immunization survey.

The immunization survey following the outbreak was undertaken jointly by the city of Plainview, the Communicable Disease Center, and the Texas State Health Department. The CDC quota sampling survey technique was used (*7*). The city was divided into four major socioeconomic areas based on the knowledge and experience of city officials. The Latin American and Negro populations were combined to form one group, and the remaining three groups were classified as lower, middle, and upper Anglo-American. Data were obtained on occupations of household heads of 428 dwelling units and on diphtheria immunizations for persons of all ages in these families, both as of November 1 (pre-outbreak) and February 16 (post-outbreak). Approximately 10 percent of the city's population was thus surveyed. Cases were fitted into the socioeconomic groups using data on race and occupation and a modification of the Hollingshead technique (*8*).

The Outbreak and Control Efforts

Fifty-six clinical cases occurred in Plainview from November 2, 1960, through January 1, 1961. Seventeen cases were confirmed bacteriologically, all but one of the isolates being from persons 14 years old or younger. The remaining 39 cases represent the presumptive diagnoses of Plainview physicians in persons ill during a proved diphtheria outbreak and having symptoms clinically compatible with diphtheria. Except for one death, the outbreak was clinically mild.

Figure 1. Major patterns of movement of Latin American agricultural workers and diphtheria, Plainview, Tex., winter, 1960



NOTE: Numbers of cases for major and minor foci are based on 1960 cases reported to the Diphtheria Surveillance Unit, Communicable Disease Center.

SOURCE: Plainview studies by Communicable Disease Center, U.S. Department of Labor, and reference 6.

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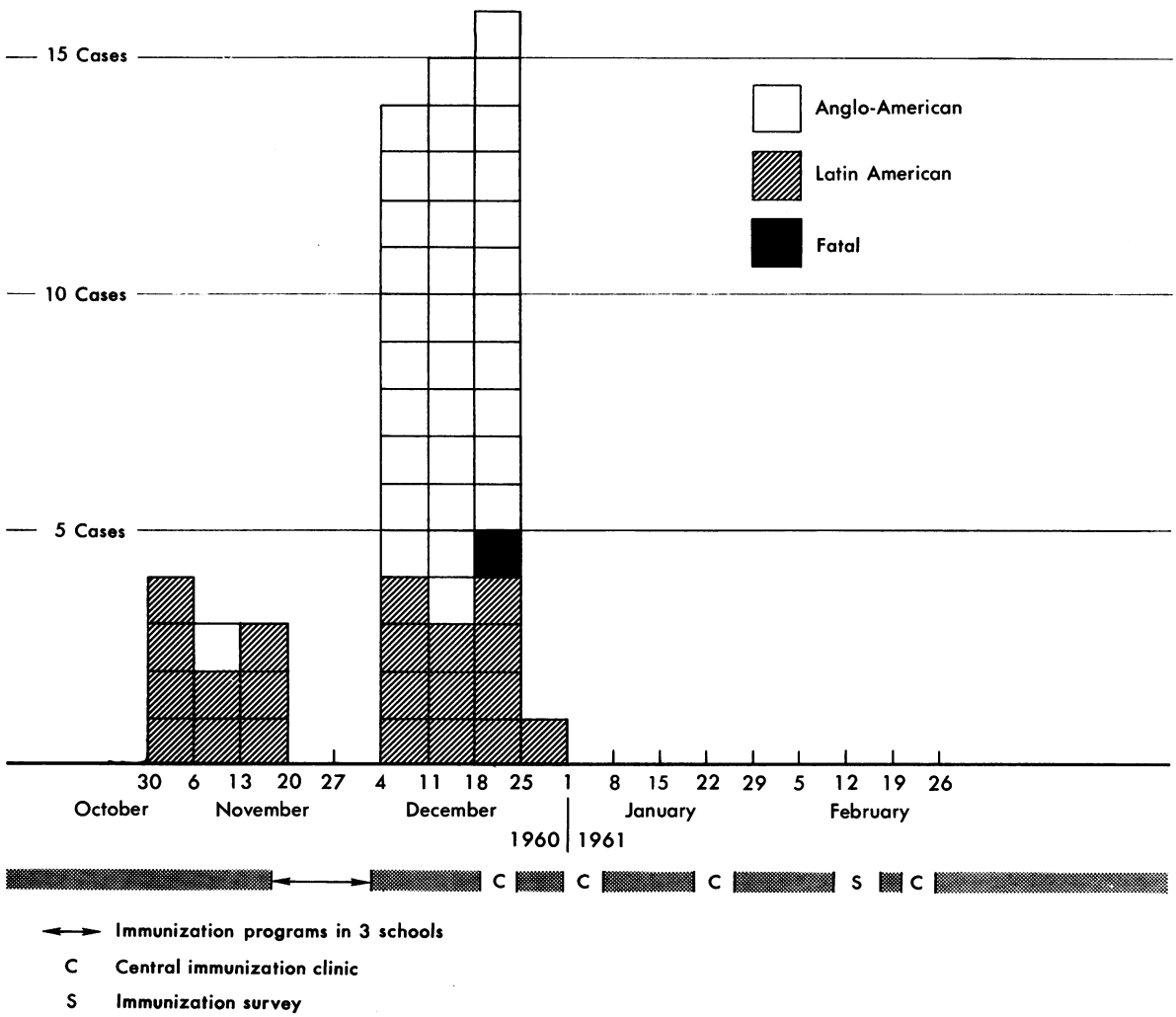
The outbreak occurred in two phases separated by a lull during which no proved case was noted (fig. 2). During the first phase, November 2–19, there were 10 cases, 8 in Latin American children. Four of the eight children attended the same elementary school. The first case was in a 10-year-old girl who went "trick-or-treating" on Halloween night in spite of a runny nose and severe sore throat of several days' duration. Her illness was diagnosed as membranous diphtheria 2 days later. On the following day three more cases were found in a Latin American family living nearby. The other six cases of the first phase were contacts of this initial cluster of four. Following these cases immunizations were begun in a population group limited to the children of the three elementary schools attended by those with diphtheria.

The discovery of 15 cases in mid-December, 11 in a single family, marked the start of the second phase. From a relatively small Latin American area infections fanned out to involve, during this phase, a more widespread population—persons of all ages in all areas of the city. It was not possible to establish a link between the two phases.

Efforts to control the outbreak consisted of attempts to identify, treat, and isolate patients and carriers, and an attempt to raise the level of immunity of all preschool and school children.

Figure 2. Diphtheria epidemic in Plainview, Tex., winter, 1960



The resurgence of cases in mid-December made more imperative a widespread immunization program, and therefore, later in December, a central immunization clinic was organized by the health unit. The goal was set of reaching 100 percent of all children in Plainview with one or more inoculations. Thorough immunization of all school children was assured by requiring that each child start a primary series or receive a booster dose prior to returning to school after Christmas vacation.

Concern that preschool children of poorer population groups might not be reached led to scheduling three more central clinics following New Year's (fig. 2). Every medium of communication in Plainview was used to publicize the free clinics: Spanish and English radio announcements and broadcasts by sound truck, newspaper schedules, and announcements by ministers of the mission churches. Within the major Latin American and Negro areas, city nurses or community leaders canvassed door-to-door.

An estimated 25,000 inoculations were given in Plainview from November 1 to February 24, about 11,700 in the central clinics and the remainder by physicians of the city. Immunizing agents, aluminum-phosphate-precipitated DTP antigen for children under 8 years and adult-type DT antigen (*9*) for persons over 8, were supplied by the Texas State laboratories. Injections were given mainly by syringe and needle. About 2,000 inoculations of precipitated antigen were given with an automatic "jet" injector, which proved to be useful because of its speed, portability, and novelty.

Epidemiologic Findings

In addition to the 56 cases (fig. 2) there were 25 asymptomatic persons, contacts of the cases, who were culture-positive ("carriers"). Of the cases, 35 were in Anglo-Americans and 21 in Latin Americans (table 1). These numbers yield rough attack rates respectively of 2.6 and 5.1 cases per 1,000 persons. Twelve families had 42 of the 56 cases, and of these families, 10 were lower Anglo-American or Latin American. There were one or more migrant agricultural workers in all but one of the nine Latin American households with cases.

The first cases of the outbreak were almost exclusively in Latin Americans, while later cases were predominantly in Anglo-Americans. There were no cases in Negroes, a fact attributed to the geographic and educational isolation of the Negro community, the relatively small Negro population, and the previous immunization of some preschool children by the nursery in the Negro community.

Forty-three percent of cases were in children 6 years old or younger, and about 75 percent of cases were in children under 14 years (table 1). The oldest person with diphtheria was 53 years old, and the youngest was a 2-month-old boy, the son of an unimmunized mother. Cases in Latin Americans tended to occur at a younger age than in Anglo-Americans. Eight

Table 1. Diphtheria cases by age, population group, and immunization status, Plainview, Tex., winter, 1960

Age group (years)	Immunization status							
	Lapsed[1]		Inadequate		None		Total	
	Latin American	Anglo-American	Latin American	Anglo-American	Latin American	Anglo-American	Latin American	Anglo-American
0–6	1	0	0	4	10	9	11	13
7–14	0	3	1	1	7	5	8	9
15–29	0	2	0	2	1	5	1	9
30 and over	0	0	0	0	1	4	1	4
Total	1	5	1	7	19	23	21	35

[1] A primary series of 3 inoculations completed more than 4 years before onset of case or a primary series at any time plus booster dose more than 4 years before onset.

cases (14 percent) were in persons over 20 years.

Case severity was estimated by attending physicians. The single death was that of a 4-year-old unimmunized Anglo-American girl, who was ill several days preceding initial medical care and had postmortem evidence of myocardial damage. Forty-four cases (79 percent) were described as clinically "mild" and 11 cases as "severe" or "moderately severe."

Of the 56 patients, 42 (75 percent) had no history of immunization, and 8 gave a history of receiving 1 or 2 doses. The 6 persons who gave histories of receiving a primary series all had illnesses described by their physicians as "mild." Conversely, all cases described as "severe" or "moderately severe" and the single death were in persons without histories of any preceding immunization.

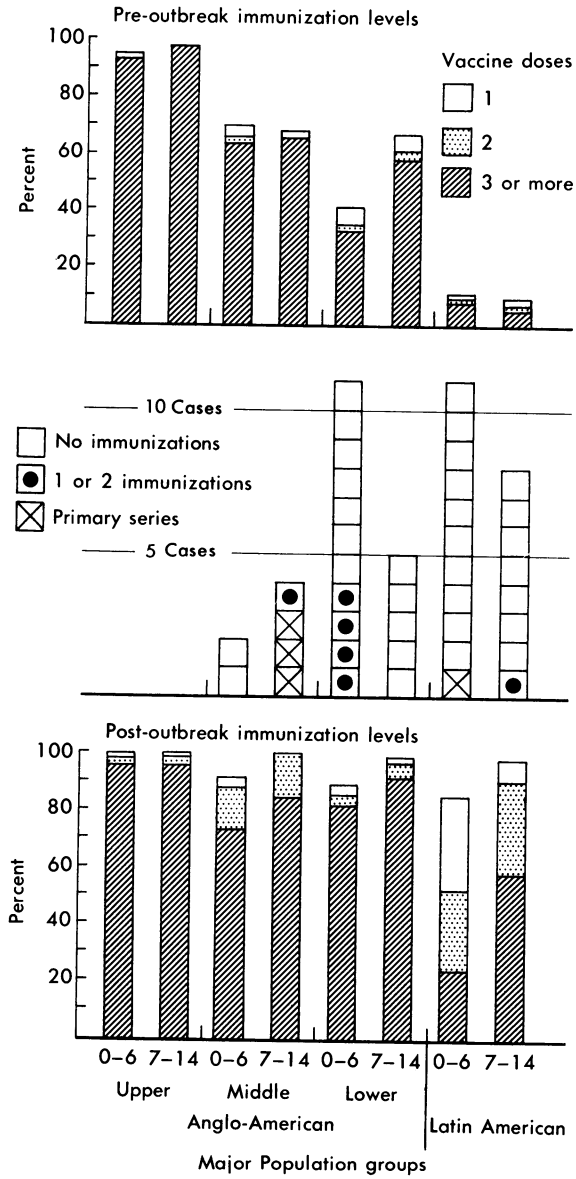
Seventeen cases were confirmed bacteriologically by the Texas State Laboratory, and of these isolates 12 were toxigenic and 5 nontoxigenic. All Plainview isolates of *Corynebacterium diphtheriae* typed by the Communicable Disease Center were *intermedius*, but a *mitis* strain was isolated from a case in an adjacent county. The Christmas mail rush, causing 1 to 1½ weeks' delay in the transportation of isolates, may have been a factor in the failure to confirm the isolation of the rather fastidious *C. diphtheriae* from 13 other specimens selected from persons with clinical cases.

Case Relationships and a Possible Source

As far as can be determined, no single common source or index case was responsible for this explosive outbreak, in spite of the suggestive epidemic curve (fig. 2). However, all cases of the first phase appeared interrelated, and school contacts seemed to have been of significance in these cases. Such evidence suggests that school contacts could likewise have been responsible for the spread of infection to a wider population in the second phase. In about 36 cases (64 percent) tentative sources of infection were determined, most of these being other known cases or carriers who were neighbors or schoolmates.

One may speculate on the role of migrant Latin American families in the outbreak. The

Figure 3. Diphtheria cases related to immunization levels in children 0–14 years old of major population groups, Plainview, Tex., winter, 1960



fact that 9 of the first 10 cases occurred in Latin Americans implies a factor in the origin of the outbreak associated in some way with this population. Several pertinent findings suggest that migrant Latin American families might have been such a factor:

1. Turnovers of as high as 50 percent of the pupils occur within classrooms of the single elementary school attended by those who had

the first cases. Such significant changes in classroom populations are caused mainly by travels of migrant Latin American agricultural families during the harvest season.

2. Preceding the outbreak, children of Latin American families from other areas of Texas were classmates of the children with the first four diphtheria cases discovered. These families came from the Harlingen-Brownsville, Asherton, San Antonio, and Florence-Temple areas (fig. 1), all areas which reported one or more cases of diphtheria earlier in 1960. *Intermedius* strains, isolated from Plainview cases, were also isolated from cases occurring in San Antonio.

3. At least one of the many Latin American families moving in late September into Siesta Courts, the home of the girl with the initial case, had children with colds and sore throats. This family, one of hundreds from south Texas working in the Plainview area during the harvest, came from Del Rio, a border town reporting a diphtheria case early in August.

4. During the months preceding the Plainview outbreak, diphtheria cases occurred in five counties of the Panhandle and southern plains area other than Hale. Extensive interchange of harvest workers among farms in these counties would tend to facilitate spread of the diphtheria organism to families and school children of all counties.

5. Diphtheria is a disease of significance in Mexico where mortality is far greater than in the United States (*10*). The south Texas cities of McAllen (Hidalgo County), Harlingen, and Brownsville are important crossover points on

Table 2. Diphtheria immunization levels in children of major population groups, Plainview, Tex., winter, 1960

Age and population group	Number of children	Percent with doses of vaccine			
		0	1	2	3 or more
	Pre-outbreak immunization levels (Nov. 1, 1960)				
0–6 years					
Anglo-American:					
Upper	47	6	2	0	91
Middle	52	31	4	2	63
Lower	49	59	6	2	33
Negro	77	75	4	1	19
Latin American	177	89	2	1	8
7–14 years					
Anglo-American:					
Upper	67	4	0	0	96
Middle	55	33	2	0	65
Lower	38	34	5	3	58
Negro	54	87	2	2	9
Latin American	158	90	3	1	6
	Post-outbreak immunization levels (Feb. 16, 1961)				
0–6 years					
Anglo-American:					
Upper	47	0	2	2	96
Middle	52	8	4	15	73
Lower	49	10	4	4	82
Negro	77	25	10	22	43
Latin American	171	15	33	28	25
7–14 years					
Anglo-American:					
Upper	67	0	1	3	96
Middle	55	0	0	15	85
Lower	38	0	3	5	92
Negro	54	0	6	19	76
Latin American	158	1	8	33	58

or adjacent to the United States-Mexico border (fig. 1). These cities have long had an untoward diphtheria morbidity, which is probably related to population movements across the border. From these border towns some of the 170,000 migrant workers in Texas, U.S. citizens of Mexican descent, begin harvest travels that take them through Plainview as members of work crews (*6*).

6. All but one of the Plainview Latin American families in which cases occurred follow the crops to some extent.

Although the evidence incriminating migrant Latin American families remains indirect, it is cited in order to emphasize the considerable hazards to all persons of a communicable disease problem within such a migrant population.

Diphtheria Immunization Survey

The purposes of the immunization survey following the outbreak were twofold: to determine the diphtheria immunization levels in the city preceding the outbreak in order to relate these levels, if possible, to the outbreak and to determine how well the mass immunization efforts of the preceding months had reached the city's population. The need for data on immunization levels in areas which experience diphtheria outbreaks has long been critical.

Results of the survey are shown in figure 3 and table 2. Immunization levels are shown for children under 15 years of age, since about 75 percent of all cases were in this group. It is apparent that diphtheria immunization levels preceding the outbreak were extremely low in the Latin American, Negro, and lower Anglo-American children. Among these groups up to 89 percent of school and preschool children in families surveyed lacked any diphtheria immunization, and in these groups 85 percent of the cases in Plainview's children occurred.

Children of the middle and upper Anglo-American groups were better protected, 91–96 percent of children in the latter group having had three or more inoculations preceding the outbreak. Only six cases occurred in these two groups.

The survey data show that mass immunizations undertaken by private physicians and the health unit reversed the low diphtheria immunization levels existing before the outbreak. Thus, in the Latin American, Negro, and lower Anglo-American groups, mainly through school or central clinics, 75 percent or more of children under 15 years received one or more inoculations and were started toward active immunity. Preschoolers in these groups, on whom strongest efforts were concentrated, had the greatest percent of increase in overall immunization levels. However, children and adults of all groups experienced marked increases in immunization levels as a result of the mass vaccination effort.

Discussion

Although it is commonly believed that the disease has largely vanished, diphtheria cases continue to occur in this country, especially among urban populations. There is continuing evidence, according to unpublished data of the Diphtheria Surveillance Unit, Communicable Disease Center, that in areas which have not reported cases in recent years, toxigenic strains are still present.

The Plainview epidemic was one of the major outbreaks of past years. It was smaller than the 1956 Detroit outbreak of 141 cases (*11*), but similar in size to the 1954–55 Meade County, Ky., *gravis* outbreak. The latter, however, was of greater severity with at least 46 cases and 8 deaths, according to unpublished CDC data. The Scott County, Ky., epidemic during fall 1960 included 51 known cases and 1 death (*1b*). The recently described Macon, Ga., outbreak of fall 1959 included at least 18 cases (*5*). One death and eight cases occurred, and six carriers were found, during a small but significant outbreak among skidrow men in Omaha during the winter of 1961 (*12*).

From data gathered during the immunization survey it is clearly evident that certain population groups were poorly immunized at the time of the Plainview outbreak. Within Latin American and Negro groups less than 20 percent of all children had received the minimum immunizing primary series of three inoculations. The vulnerable Negro population was spared a single case. Among the other children in Plainview, however, there was a striking inverse correlation between immunization levels

for each population group preceding the outbreak and the number of cases occurring in that group.

Because of efforts continued over a 10-week period, through the central clinic and the physicians of the city, the majority of all children received at least one inoculation and almost two-thirds received two or more by mid-February 1961. School children, a "captive" population, became essentially fully immunized. Thus it was demonstrated that through the use of all possible communications media, and with special emphasis on reaching the medically needy, an entire city may be relatively rapidly started toward full immunity against an infectious disease.

The relationships of migrant agricultural workers to the outbreak cannot be finally known. However, the indirect evidence that first cases were among Latin American families, most of them migrant to some degree and with children who had schoolmates from other areas in Texas where diphtheria cases had occurred, suggests that migrant families may have been a causal factor. The occurrence of five later cases in Lee County, Ill. (*13*), among Latin American workers from southern Texas including San Antonio and Del Rio certainly lends additional credence to such a theory. For this small cluster unequivocally demonstrated diphtheritic infection within a migrant Latin American population of common origin with that of Plainview.

Endemic infection as a source of this community's outbreak cannot be rigorously ruled out. But regardless of the ultimate causal factors, it is highly likely that widespread lack of previous immunization in many of the city's children was of fundamental importance in the development, spread, and perpetuation of the outbreak, for the efficacy of adequate immunization in the prevention of diphtheria cases cannot logically be doubted (*14*, *15*).

Several recent reviews (*16–19*) have called attention to the many-faceted problems of health among the 500,000 migrant agricultural workers in this country and their children, although such problems have received relatively little attention in the medical literature. At least one comprehensive study has been carried out, demonstrating a significant incidence of such diseases as pulmonary tuberculosis, gonorrhea and syphilis, and rheumatic heart disease within a representative group, workers in the Snake River Valley (*20*). In this study, immunization levels among Latin American and Indian families were found to be generally unsatisfactory.

Data collected during the Plainview outbreak suggest the possibility that immunization levels of the Negro and Latin American populations generally may be unsatisfactory. If this is true, these population groups, as well as the many communities in which they live, face needless hazards, including those due to certain types of communicable disease within mobile populations. Some possible consequences of such low immunization levels are well illustrated by the Plainview outbreak.

The lesson of Plainview is clear. If future outbreaks of diphtheria are to be aborted, immunization levels of all population groups, including those of lower income groups, both stable and migrant, must be raised to and maintained at adequate levels.

Summary

Between Halloween 1960 and New Year's Day 1961, an epidemic of 56 diphtheria cases including 1 death occurred in Plainview, Tex. First cases were among children of Latin American descent, but other population groups were later involved. Cases were predominantly among unimmunized children and were caused by *intermedius* infection. All severe cases were in unimmunized persons.

Study of the outbreak, including a survey of immunization levels preceding and following the outbreak in all population groups, demonstrated a strong inverse correlation between the number of cases in each group and that group's level of diphtheria immunization before the outbreak. A vigorous effort by the city resulted in a start toward full immunization for more than 75 percent of the city's children.

Indirect evidence strongly suggests that unimmunized migrant agricultural workers played a central role in the Plainview epidemic. The outbreak emphasizes the need for continuing and energetic immunization measures in all population groups.

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Whole-Body Radiation Counter

A radiation counter capable of recording radioactivity in 18 separate sections of the body is being used for research at the National Institutes of Health, Public Health Service. The new counter, more flexible and sensitive than any other built so far, makes it possible to detect minute amounts of radioactive material within the body and to determine where it is. It can measure the total amount of radiation in the body in 2 or 3 minutes.

Among its research applications will be studies of blood and metabolic disorders and the intake of radioactive iodine from fallout by infants and children. In other projects, the counter will be used with a second body radiation counter that can sort out and identify specific isotopes. The subjects of these studies will range from the distribution of potassium in the body to the effectiveness of various types of radiation shielding for sensitive instruments.

The counters are housed in rooms constructed of 6¼-inch thick armorplate salvaged from old battleships. The old plate was used to reduce background radiation to a minimum, since modern steel may contain some radioactivity.